



Introduction – Cognitive penetration and predictive coding. Pushing the debate forward with the recent achievements of cognitive science



1. The debate

This special issue aims at bringing together two debates in recent philosophy of mind. The first debate is part of the philosophy of perceptual experience. We observe an intense discussion on the question whether the activation of higher-level cognitive states like concepts, beliefs, desires etc. is capable of influencing perceptual experience, while this modification would only be interesting if it affects perceptual process and not just the perceptual input or the perceptual judgment. Such a phenomenon is known as the cognitive penetrability of perceptual experience (CP). The second debate is based on the introduction of a new functional framework for analyzing brain processes, namely the predictive coding framework (PCF), with the open question of how fruitfully this framework can be used to reach explanations of central phenomena of the human mind including perception. The central idea of predictive coding, as put forward recently in some detailed accounts especially by [Friston \(2010\)](#), [Hohwy \(2013\)](#) and [Clark \(2013\)](#), states that the brain constantly models the outer world according to Bayesian principles, in order to predict the incoming sensory information. To make a connection with the debate about CP, which is usually discussed relying on the example of visual experience, PCF must be applicable on the relevant levels of perceptual processing. The basic idea is the following: the prior predictive information is fed down to lower stages via feed-back connections and influences the processing on these lower levels. At the relevant lower level, the predicted information and the incoming sensory information are compared, and a possible mismatch is extracted as an error signal. This error signal is communicated in a feed-forward way to the higher levels of processing where it corrects and adjusts the predictive model. Via further recurrent loops, a better predictive model is computed and fed down again to the sensory input layer until a sufficiently low error signal is achieved. In PCF, top-down influences play a crucial role as they carry the most important information: the prediction on how the sensory information is likely to be composed. The special issue is structured into one introductory section and two main sections with the first investigating the core of the debate about CP and the second addressing the relation between CP and PCF, a topic that has never been specifically addressed so far in a dedicated volume.

2. The structure of the contributions

A first obvious question is how the two debates of CP and PCF are related to each other. Is CP just a special case of predictive coding or is the relation much more complex? An answer is given in our first introductory section of the special issue, which consists of only one article by Fiona Macpherson. She develops a complex description of relations between the two debates depending on the understanding of the impenetrability claim that is the central tenet of the camp denying cognitive penetration.

A second question, is whether there is new convincing evidence together with theoretical considerations that allow us to make the case for cognitive penetration stronger. This is especially necessary in the light of the recent denial of top-down effects on perception by [Firestone and Scholl \(2015\)](#). Thus, our second section aims to deliver new conceptual considerations in the light of the available empirical evidence to re-examine the case for cognitive penetration.

A third question is whether PCF can completely integrate the proposed phenomenon of cognitive penetration and if so which modification have to be made to realize this. Is PCF so powerful that it actually enriches the explanation and understanding of cognitive penetration?

3. Conceptual clarifications and the conceptual relations

In the opening article of this special issue *Fiona Macpherson* argues that the relationship between the PCF and CP is dependent on both, the specific form of predictive coding and the specific form of penetrability that are presupposed. She spells out the different forms and explains the critical relations for each possible combination of accounts. Contrary to a superficial reading, it becomes very clear that a mere acceptance of the PCF's approach to perception does not determine whether one should think that CP exists. The reason is mainly this: There are different understandings of "higher-level cognitive states". In PCF a higher-level cognitive state is only relatively higher than one neighboring lower-level state and this has no direct implications for cognitive penetration. CP involves a characterization of higher-level cognitive states in a much more general sense, i.e. these are higher-level states compared to all the cognitive processes in the brain relevant to realize all cognitive abilities. This much more demanding notion is compatible with the PFC framework and it allows for both the specification and denial of the involvement of higher-level cognitive states in this sense. Since there are also different versions of understanding penetrability (resp. impenetrability) it follows that we can have a complex variety of possible accounts, which are presented in an overview. The upshot for the debate is, thus, that all future contributions should clarify which understanding of PCF or CP they presuppose.

4. Cognitive penetration defended

In an ideal case of CP not only the perceptual input received by a subject with a normally functioning sensory system is fixed (which presupposes stable perceptual circumstances) but so is the subject's attention. We say that a perceptual experience has been cognitively penetrated if, under the conditions specified above, a modification in the subject's activation of higher-level cognitive processes, e.g. the activation of a concept, belief, desire etc., results in a modification of the subject's perceptual experience. In this debate the role of attention is a tricky one and needs explicit discussion, as the reader shall see in several of the contributions to this volume. Before describing the central ideas of the papers in this section, which focuses on CP, let us have a glance at the history of this debate.

The notion of cognitive penetrability was first introduced by *Pylyshyn (1980)*; see also *Fodor & Pylyshyn, 1981*). However, the possibility of top-down effects on perception was discussed much earlier, indeed it was the core idea behind the *new look* movement in psychology. The *new look* focused on several alleged cases of top-down effects, such as the effects of value attribution on the perception of size (*Bruner & Goodman, 1947*). Despite some initial success, the *new look* movement was exposed to some significant worries. Later, the idea was almost abandoned, in part due to the influence of computationalists like *Fodor (1983)* and *Pylyshyn (1980, 1999)*, who were concerned with the characterization of a reliable visual system that is capable of representing the world adequately, i.e. of delivering some true information. One famous example of the critics is Fodor's argument for the impenetrability of visual illusions such as the Müller-Lyer illusion. In addition, Pylyshyn describes a functionally characterized early visual system that he calls *early vision*. Pylyshyn was driven by the consideration that in order to function quickly and reliably, part of the visual system must work independently of information stored in any other cognitive domain. Furthermore, most experimental findings of *top-down* effects of cognition onto perception were exposed to another powerful objection: the methodology employed by most experiments, largely based on subject's reports, was incapable of distinguishing between real changes in subjects' perceptual experiences and changes in their perceptual judgments.

In recent years, however, the interest of the scientific community in the possibility of *top-down* effects has risen once again to an impressive extent. On the one hand, empirical researchers offered a battery of new experiments, especially in social psychology and psychology of perception, based on the development of new experimental paradigms (e.g. *Hansen, Olkkonen, Walter, & Gegenfurtner, 2006*; *Witzel, Valkova, Hansen, & Gegenfurtner, 2011*), which aimed at moving away from relying exclusively on subjective reports. On the other hand, the philosophical community presented strong arguments based on the best available experimental evidence, to support cognitive penetration (e.g. *Macpherson, 2012*; *Marchi & Newen, 2015*; *Siegel, 2011*; *Vetter & Newen, 2014*). The new wave of interest in the CP debate is so impressive that the University of Yale reports more than 170 empirical papers on *top-down* effects of cognition onto perception since 1995 (www.yale.edu/perception/Brian/refGuides/TopDown.html).

Despite such an extensive list of alleged effects, this contemporary strand of the *new look* movement has its own relentless critics. In a recent article *Firestone and Scholl (2015)* expose some critical methodological worries that target the majority of the most recent empirical findings. Some of these worries are closely related to the original objections, while some are new. Regardless of the still open question about the real import of each of their worries, Firestone and Scholl have provided a useful benchmark for any compelling empirical evidence of CP. In this section of the volume, we gather several contributions that fit into the new debate about CP and span from its neurophysiological plausibility to its implications for other domains of cognitive science.

In the 2nd article of this volume, *Christoph Teufel and Bence Nanay* propose to redefine the traditional issues concerning CP, once we have a clear picture of the extent and relevance of top-down information processing in the brain. Focusing on perceptual processing, which they clearly distinguish from perceptual phenomenology, they examine the possibility of top-down processing without establishing prior definitions of perception and cognition. In this way they attempt at reversing the typical explanatory order of the CP debate. After having examined the structure and properties of top-down connectivity

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